Communication with Self-Interested Experts Part I: Introduction and Models of Verifiable Disclosure

Margaret Meyer

Nuffield College, Oxford

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Setting: Decision-maker (P) receives advice from an advisor (A) who possesses useful information but whose preferences over possible decisions don't match those of P. After receiving advice, P makes a decision.

Examples:

1. manager consulting supervisor about an employee
2. headquarters consulting a division manager about an investment project
3. investor evaluating information disclosed by a firm's management
4. politician listening to a lobbyist representing an interest group
5. customer asking a salesman about a product's quality

Maintained assumptions: Decision-maker *cannot commit* in advance as to how will use advisor's advice and hence cannot offer monetary transfers contingent on the advice. Contrast mechanism design.

NB: Signaling and signal-jamming models can also be used to study communication, but in these, emphasis is on *effort expended* as well as on information transmitted.

We will examine two classes of communication models:

1. "Cheap talk" ("soft" information) - advisor can *costlessly* say *anything*
   - seminal paper: Crawford and Sobel, *Econometrica*, 1982
   - surveys: Sobel, *Adv. in Econ. and Etrics*, 2013; Farrell and Rabin, *JEP*, 1996
2. "Verifiable disclosure" ("hard" information) - advisor *cannot* report *false* information, but *can suppress* information.
   - seminal papers: Milgrom, *Bell J.*, 1981; Grossman, *JLE*, 1981
   - survey: Milgrom, *JEP*, 2008; Dranove and Jin, *JEL*, 2010

Verifiable disclosure models rest on two premises:

- Fabrication of evidence can be detected and punished severely enough to deter it.
- Not possible to determine truth or falsehood of claim such as "I have no information on that issue".

NB: Some types of claims may be "intermediate" between verifiable information and cheap talk, e.g. scientific evidence consists of experimental findings plus interpretation. How to model this intermediate type of information?

Strategic communication models: Key questions

1. How do decision-maker and expert behave in eqm. of a particular communication game? How much information is communicated? How good is the quality of decisions?
   - How do answers compare btw. hard and soft information?
   - How do answers vary with nature and degree of divergence in preferences?
2. How do different environments for communication affect expert's *incentives* to *acquire* information?
3. Could delegation of decision-making authority to an expert (if credible) be preferable to communicating with him? What restrictions on expert's choice set (if credible) would be beneficial?
4. When, and how, does presence of multiple experts affect communication and decision-making? How best to communicate with multiple experts?
5. If experts are consulted repeatedly, do they become concerned about their reputations for accuracy or objectivity? When do reputational concerns enhance or diminish quality of decision-making?

Alternative model of strategic information generation: "Bayesian persuasion"

- Seminal paper: Kamenica and Gentzkow, *AER*, 2011; survey: Kamenica, *Ann. Rev. of Econ.*, 2019
- Expert, **before** becoming privately informed, costlessly chooses an "experiment", i.e. a procedure for generating an informative signal about the state of the world, and expert **publicly commits** to this procedure.
- The signal is observed by both the decision-maker and the expert.
- So the expert is choosing the distribution of posterior beliefs for the decision-maker, subject only to the constraint, stemming from Bayesian updating, that the expectation of the posterior mean equals the prior.
- What is the optimal signal-generating procedure for the expert to choose?
  - How much information should he generate, and of what form?
  - In equilibrium, can the expert's attempt at persuasion be effective, i.e. does the ability to choose a signal-generating procedure raise the expert's eqm expected payoff? Under what conditions?

Part I: Verifiable Disclosure Models

Principal P wants to tailor his decision to the unknown state of the world, while agent A wants P to make as large a decision as possible. Legal sanctions or costs of fabrication deter false reports by A. Examples:

- P: customers deciding willingness to pay; A: salesman; decision = price
- P: investors bidding for shares; A: manager; decision = share price
- P: parent; A: pupil with info about school reports; decision = reward/punishment

x = state of the world, with commonly known cdf F. V = P's decision.

P's payoff $= -(V - x)^2$; A's payoff $= V$; P and A are risk neutral.

- P optimally sets V equal to the posterior expectation of x.
- Hence a single P with quadratic loss function gives a reduced-form representation for outcome of competition among customers/investors bidding the price up to the posterior expected value of the good/asset.

Part I: Verifiable Disclosure Models

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P's payoff $= -(V - x)^2$; A's payoff $= V$; P and A are risk neutral.

Information Assn.*: It is common knowledge that A learns x but P does not.

Timing: i) A receives his private information; ii) A chooses what information, if any, to verifiably disclose to P; iii) P chooses V, and payoffs accrue.

Verifiable Disclosure Assn.: In choosing what to disclose, A can report nothing or any true statement about x.

- As we'll see, it is wlog to restrict A's disclosure rule $r(x)$ so that $r(x) \in \{x, \phi\}$.

The Unraveling Result

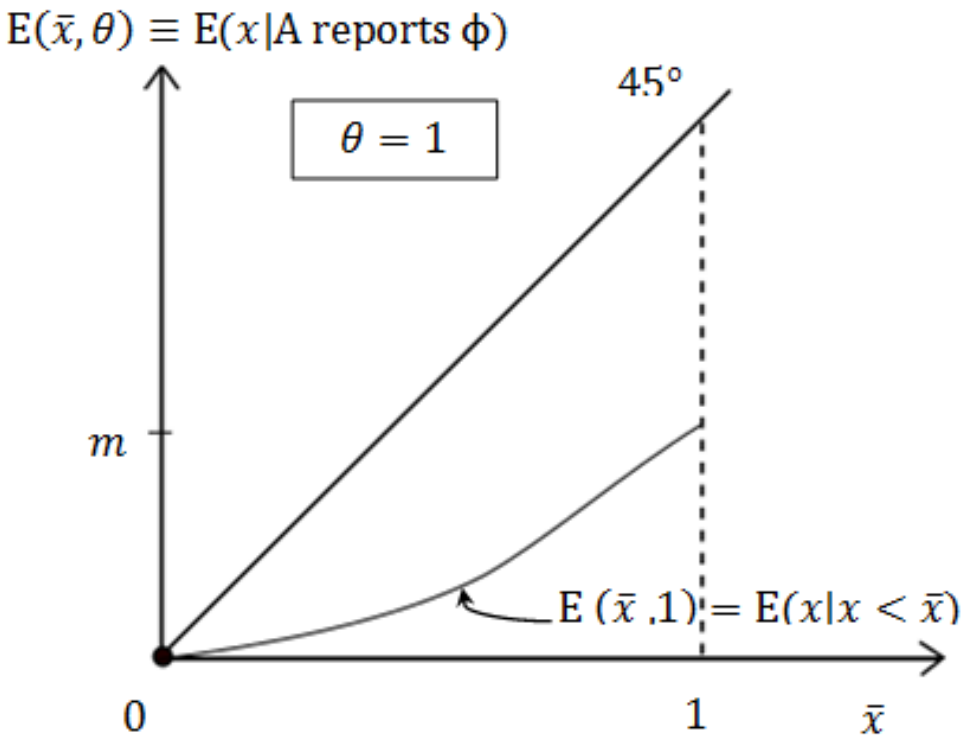
Consider first $x \in \{0, 1\}$.

- If $x = 1$, A reports "$x = 1$": $r(1) = 1$
- If $x = 0$, A reports either "$x = 0$ " ($r(0) = 0$) or nothing ($r(0) = \phi$); in either case, P infers that $x = 0$.
- Hence, for both $x = 0$ and $x = 1$, in equilibrium P makes his "full-information optimal decision".

Now let $x \in \{0, 1, 2\}$.

- Is there a partially-pooling eqm with $r(0) = \phi$, $r(1) = \phi$, $r(2) = 2$?
- **No.** Such an equilibrium would "unravel":
  - Suppose P believes A uses the strategy above and optimally responds to it.
  - Then when P receives $r = \phi$, it is optimal to set $V(\phi) \in (0, 1)$.
  - Hence when $x = 1$, A would prefer to deviate and disclose the state (i.e. use $r(1) = 1$), thereby ensuring a payoff of 1.

Proposition: The Unraveling Result (Milgrom, 1981; Grossman, 1981)
Suppose messages are verifiable and it is common knowledge that A learns the state of the world. If A's preferences are commonly known and if A's ranking over P's actions is monotonic and independent of the state of the world, then in every sequential eqm of the disclosure game, P learns the state of the world.



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- **Remark:** Eqm. behavior (the mapping from x to V) remains unchanged if A can choose between reporting ϕ and making **any** truthful report about x.
  - Suppose there were an eqm. in which, for all $x \in [k, k+\Delta]$, A reported "$x \geq k$" and P (correctly) responded to this message by choosing $V > k$.
  - Then an A who saw $x = k + \Delta$ would have an incentive to deviate and report "$x = k + \Delta$" or any other true statement which an A who saw $x < k + \Delta$ could not verifiably make.
  - Any pooling of this form would "unravel".
  - Hence, if the message "$x \geq k$" were used in eqm., P would interpret it in the **most skeptical** way, i.e. as "$x = k$."

The Unraveling Result is driven by maximal skepticism



Generalizations of the Unraveling Result

a) Weaker assumptions about A's preferences

b) Weaker assumptions about P's information and sophistication, along with competition among agents

a) *Weaker assumptions about A's preferences:*

- Seidmann and Winter (*Etrica*, 1997) allow A's optimal decision to vary with the state of the world.
- They show that if A's optimal decision is either greater than P's optimal decision in all states, or less than P's optimal decision in all states, then the unraveling result still holds.
  - e.g. A's payoff $= -(V - (x + b))^2$, with b a commonly known constant

Generalizations of the Unraveling Result

b) *Weaker assumptions about P's information and sophistication, along with competition among As*:

- Milgrom and Roberts (*Rand*, 1986) stress that with one A, the unraveling result requires that
  - i) P knows A's preferences;
  - ii) P knows factors about which A has information, so knows when infor. is being withheld; and
  - iii) P is sophisticated, so draws correct inferences when infor. is withheld.

- They show that **competition** among interested parties can allow P to make the full-info decision, even if these conditions are violated.

  - Each agent chooses whether/what to verifiably disclose.
  - P makes the full-information optimal decision as long as it is always Pareto-undominated among the As, i.e. in every state and for every decision d, $\exists$ an A who is well-informed and who prefers the full-infor. decision to d.
  - This condition ensures that As have no collective interest in misleading P and always have enough information to guide P to his preferred decision.

When does the Unraveling Result fail to hold?

In absence of competition among interested agents, why might complete voluntary disclosure of verifiable info fail to arise in eqm?

1. P may be uncertain how well-informed A is (Dye, 1985; Okuno-Fujiwara et al, 1990; Shin, 1994)
2. Information may be costly for A to disclose verifiably (Jovanovic, 1982)
3. A may face uncertain costs of acquiring info (Shavell, 1994)
4. P may be uncertain about direction of misalignment in incentives (Einhorn, 2007)

Under any of these conditions, when A does not disclose information, P cannot be sure of the reason why.

- For 1., 2., and 3., P cannot necessarily infer that A was strategically suppressing unfavorable info.
- For 4., P cannot be sure what info A regarded as unfavorable.

When does the Unraveling Result fail to hold?

Another reason why the unraveling result may fail is competition among privately-informed *A*s, *where disclosure of private information affects intensity of competition* (Board, 2009)

- Duopolists producing vertically differentiated products know qualities of all products, whereas consumers do not
- Duopolists simultaneously decide whether or not to disclose own quality; then compete in prices
- In eqm, higher-quality firm discloses (unraveling logic)
- Lower-quality firm discloses only if its quality is an intermediate fraction of high-quality firm's
  - If its quality is close to high-quality firm's, disclosure is deterred because price competition would be too intense
  - If its quality is very low, non-disclosure allows it to pool with high-quality types of lower-quality firm

A Model with Partial Disclosure in Eqm (cf. Dye, 1985)

Replace **Information Assn.*** with

Information Assn.:** With prob. θ, A learns x. With prob. $1-\theta$, A learns nothing (ϕ). P does not know what A has learned, and if A has learned nothing, he cannot certify this to P. The value of θ is common knowledge.

Let $x \sim$ on [0,1] with commonly known cdf F, density $f > 0$, and $Ex = m$.

As before, it is wlog to assume that if A learns x, A's report $r(x) \in \{x, \phi\}$.

Claim: There exists a unique PBE, characterized by a critical value of x, $\overline{x}^*(\theta)$, such that

i) if A learns x and $x \geq \overline{x}^*(\theta)$, A reports x (i.e. $r(x) = x$);

ii) if A learns x and $x < \overline{x}^*(\theta)$, A reports nothing (i.e. $r(x) = \phi$);

iii) if A learns nothing, he reports nothing (i.e. $r(\phi) = \phi$).

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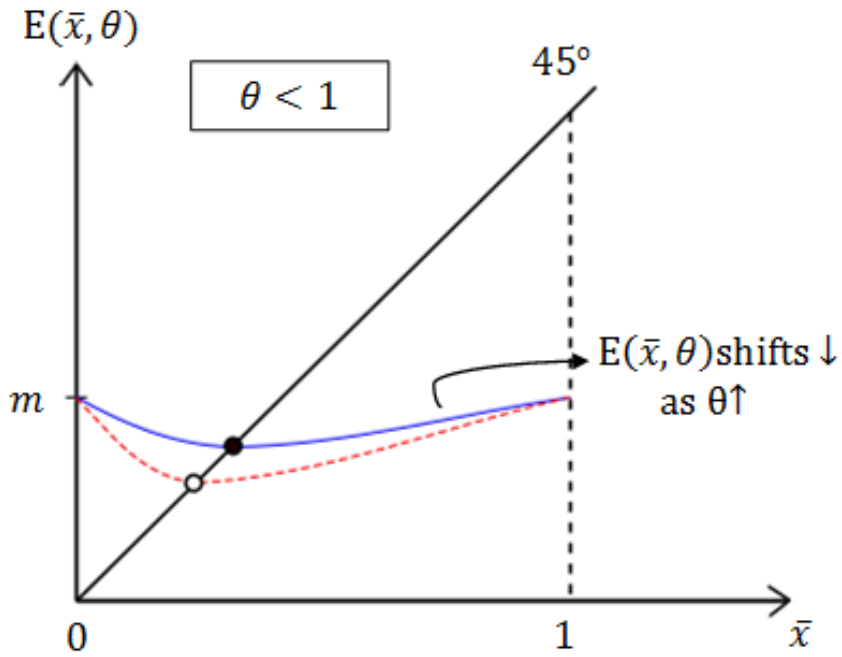
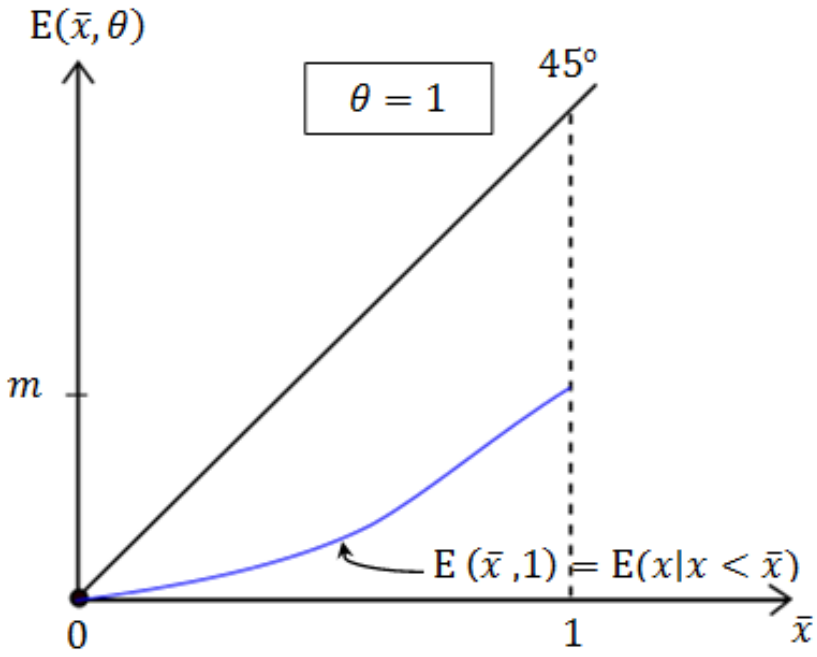
To verify claim: Suppose P conjectures that A uses a strategy of the above form, for some $\overline{x}$. Then P believes that $P(A \text{ reports } \phi) = 1 - \theta + \theta F(\overline{x})$.

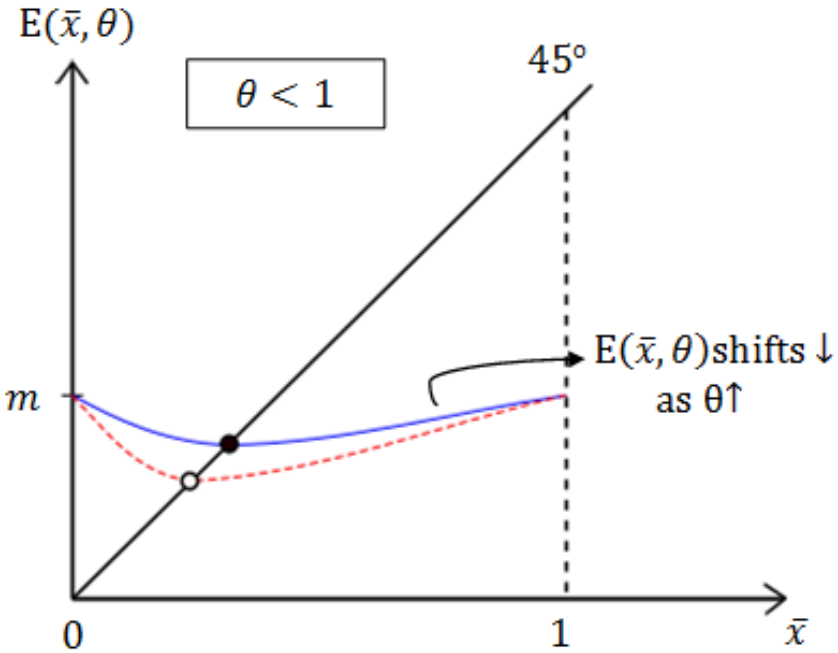
P's optimal response to a report of ϕ, denoted $E(\overline{x}, \theta)$, is $E(x \mid A \text{ reports } \phi)$:

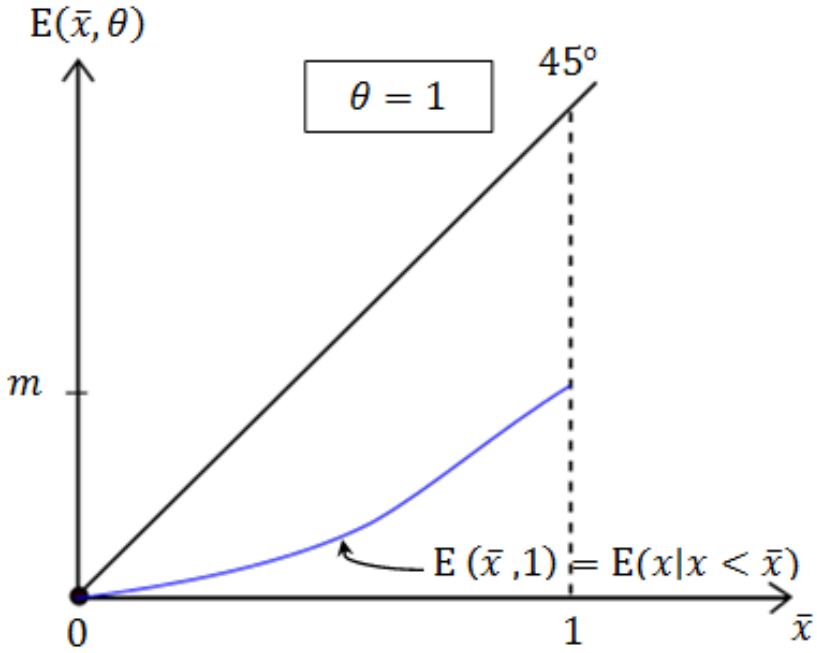
$$\begin{aligned} E(\overline{x}, \theta) &= \left(\frac{1-\theta}{1-\theta+\theta F(\overline{x})}\right) m + \left(\frac{\theta F(\overline{x})}{1-\theta+\theta F(\overline{x})}\right) \frac{\int_0^{\overline{x}} x f(x) dx}{F(\overline{x})} \\ &= \text{weighted average of } \; m \quad \text{and} \quad E(x \mid x < \overline{x}) \end{aligned}$$





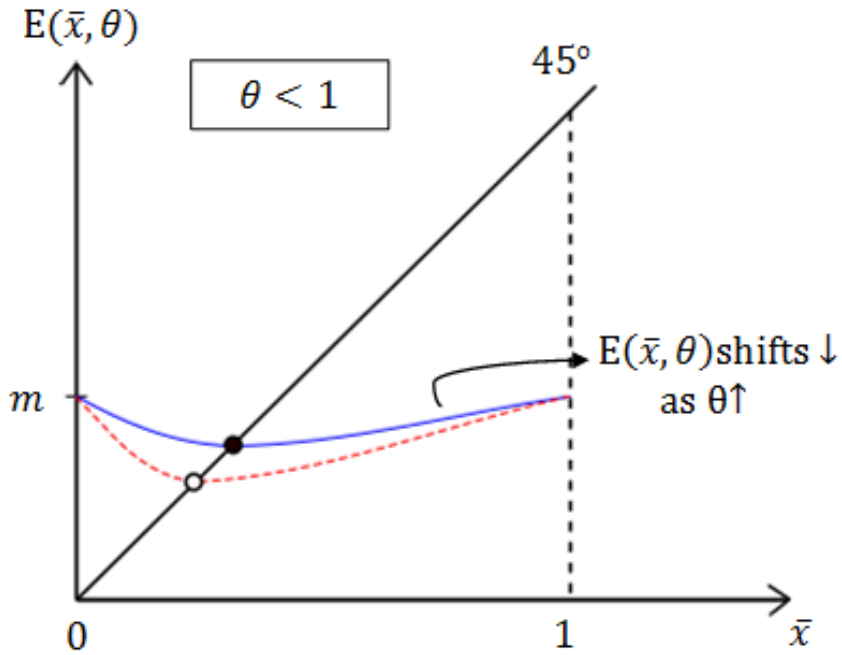
- $E(0,\theta) = E(1,\theta) = m$ for all $\theta < 1$;
- $E(\overline{x},\theta) < m$ for all $\overline{x} \in (0,1)$, for all $\theta > 0$;
- $E(\overline{x},\theta)$ is U-shaped in $\overline{x}$, for all $\theta < 1$, and minimized at $\overline{x}$ s.t. $\overline{x} = E(\overline{x},\theta)$.
  - **Analogy:** with fixed costs and increasing marginal costs (MC), average cost (AC) is U-shaped and minimized where MC=AC.
  - Here, 45°-degree line $\overline{x}$ is analogous to MC and $E(\overline{x},\theta)$ to AC.
- **An eqm. value of $\overline{x}$ must satisfy $\overline{x} = E(\overline{x},\theta)$, since A prefers to disclose x if $x > E(\overline{x},\theta)$ and to suppress x if $x < E(\overline{x},\theta)$.**

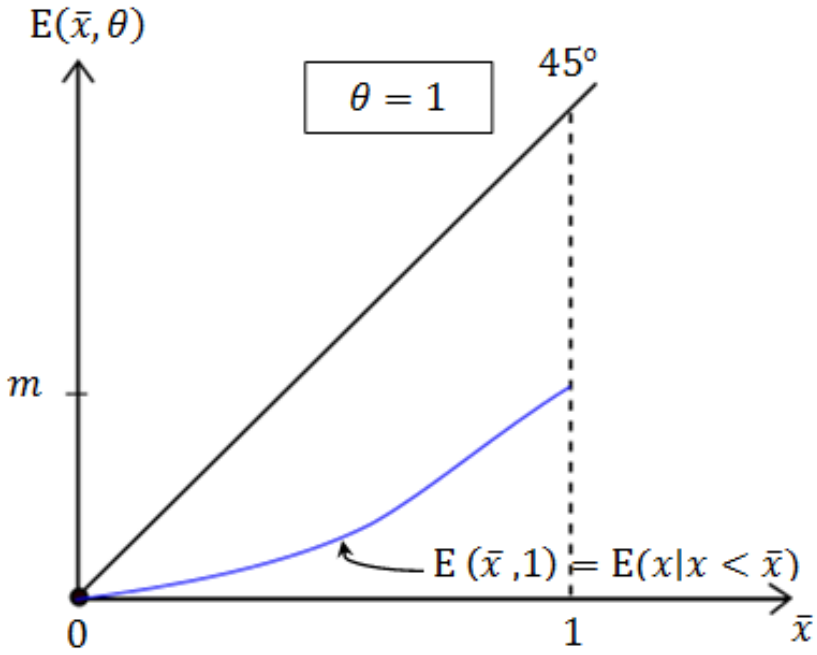




The MC/AC analogy implies i) there is a *unique* value of $\overline{x}$, $\overline{x}^*(\theta)$, satisfying $\overline{x} = E(\overline{x}, \theta)$, i.e. eqm is unique; ii) $\overline{x}^*(\theta)$ is the value of $\overline{x}$ that minimizes $E(\overline{x}, \theta)$.

- For all $\theta \in (0, 1)$, $\overline{x}^*(\theta) \in (0, m)$: Since $\overline{x}^*(\theta) > 0$, *some information is suppressed in eqm.*
- Since $E(\overline{x}, \theta)$ is $\downarrow$ in θ, $\overline{x}^*(\theta)$ is $\downarrow$ in θ: As $\theta \uparrow$, less information is suppressed in eqm.
- $\lim_{\theta \to 1} \overline{x}^*(\theta) = 0$: As $\theta \to 1$, we recover the unraveling result.

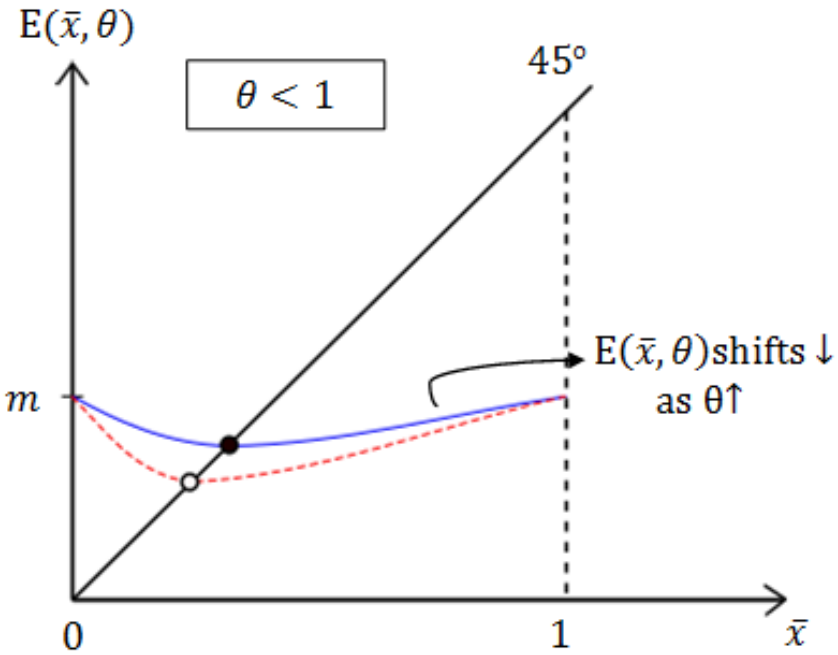


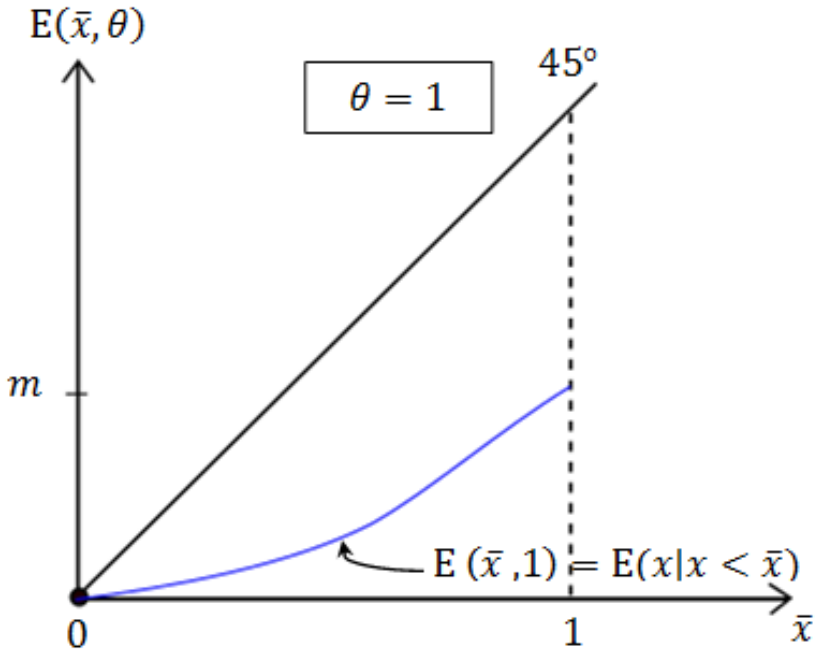


As $\theta \uparrow$, P's payoff $\uparrow$, for 2 reasons:

1. direct effect: higher prob. that A is informed, for any given $\overline{x}$.
2. indirect effect: higher prob. that A discloses x, since $\overline{x}^*(\theta) \downarrow$ in θ.

Remark: For any $\theta < 1$, as $\overline{x} \to 0$, $E(\overline{x}, \theta) \to m$ and $\frac{\partial E}{\partial \overline{x}}(\overline{x}, \theta) < 0$. As $\theta \to 1$, $\frac{\partial E}{\partial \overline{x}}(0, \theta)$ becomes very negative. However, for $\theta = 1$, as $\overline{x} \to 0$, $E(\overline{x}, \theta) \to 0$. There is no inconsistency, but the order of the limits $\overline{x} \to 0$ and $\theta \to 1$ matters.





- Given θ, in eqm, A **chooses disclosure threshold $\overline{x}$ that minimizes P's decision following no disclosure** $E(\overline{x}, \theta)$ (recall MC/AC analogy).
- DeMarzo, Kremer, and Skrzypacz (2019) generalize this result to a setting where A privately and costlessly chooses a "test" (what info to learn about the state) as well as what to disclose.
  - Assume every test, with some probability, fails to yield any info to A.
  - **Result:** A's eqm. strategy (choice of test and disclosure rule) satisfies **"minimum principle"**: minimizes P's decision following no disclosure.

Applications of verifiable disclosure models

Verifiable disclosure models have been influential in the finance and accounting literatures studying the reaction of stock prices to managerial earnings announcements:

- Models such as this one, in which some unfavorable information is strategically suppressed in eqm., may help explain the following empirical regularity: Disclosures interpreted negatively by the stock market are associated with higher subsequent return volatility than disclosures interpreted positively. (See Shin, *Rand*, 1994; Shin, *Etrica*, 2003.)

- Acharya, DeMarzo, and Kremer (*AER*, 2011) use this model to study the strategic *timing* of information disclosure, showing that clustering of negative announcements by firms can arise in eqm.

How does disclosure "environment" affect incentives for info acquisition?

Applications to

- Product markets: regulation of disclosure about safety/quality affects firms' incentives for product testing
  - Matthews and Postlewaite, *Rand*, 85; Shavell, *Rand*, 94; Henry, *EJ*, 09
- Financial markets: regulation of disclosure about adverse events impacts managers' incentives for investigation
  - DeMarzo, Kremer, and Skrzypacz, *AER*, 19
- Financial advice: regulation of disclosure about advisors' commissions on different products affects advisors' incentives to invest in information useful to customers
  - Inderst and Ottaviani, *JEL*, 12; Onuchic, W.P., 20
- Legal proceedings: "discovery rules" impact lawyers' incentives to uncover evidence
  - Allen et al, *JLegS*, 90
- Competition policy: regulation of disclosure to competition authorities affects firms' incentives for investigating impacts of proposed mergers
  - Lagerlöf and Heidhues, *IJIO*, 03

Model verifiable disclosure preceded by strategic info acquisition by A:

- P's payoff $= -(V - x)^2$; A's payoff $= V$
- $x \in \{0, 1\}$, $Prob(x = 1) = p \in (0, 1)$
- With prob. θ, A learns x, and with prob. $1 - \theta$, A learns ϕ.
- A **chooses** the probability θ, at personal cost $C(\theta)$, where $C'(0) = 0$ and $C''(\theta) > 0$ for all θ.
- The value of p and the form of $C(\theta)$ are common knowledge.
- P does not observe θ, $C(\theta)$, or the information (if any) acquired by A.

Three benchmarks:

Benchmark 1: θ is exogenously fixed and common knowledge

Benchmark 2: P cannot observe what A learns but *can* observe (though not contract on) A's choice of θ

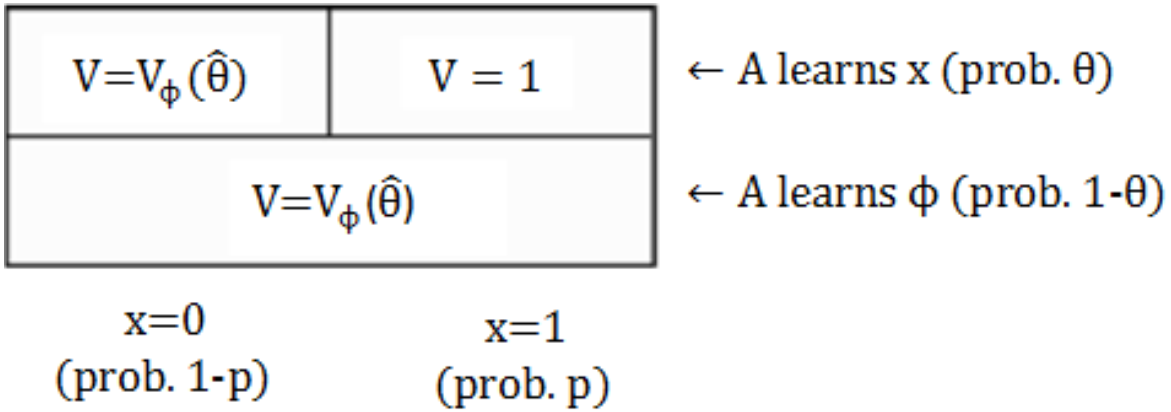
Benchmark 3: P cannot observe θ but *can* observe what A learns

Benchmark 1: If $\theta \in (0,1)$ is exogenously fixed and common knowledge, then disclosure game has a unique PBE:

- A discloses $x = 1$ and suppresses $x = 0$
- If $r = 1$, P chooses $V = 1$. If $r = \phi$, P chooses

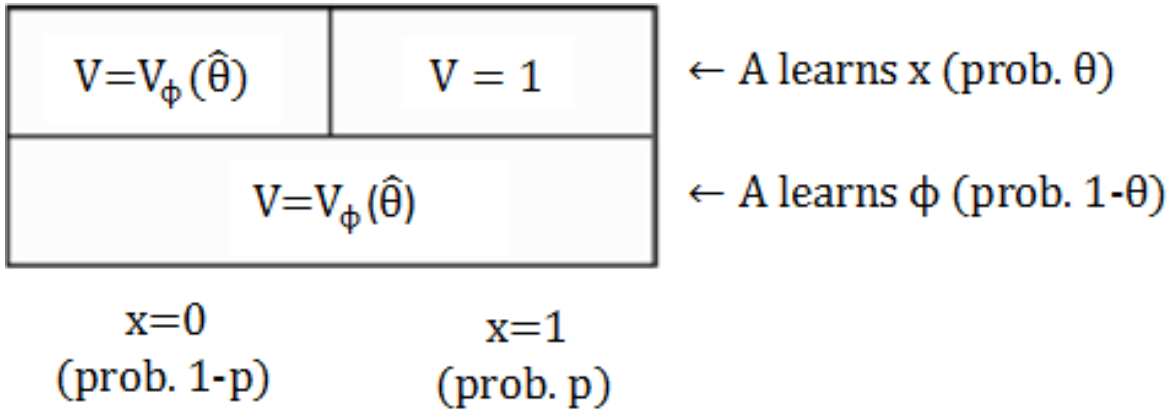
$$V_\phi(\theta) \equiv E(x \mid r = \phi) = P(x = 1 \mid r = \phi) = \frac{(1-\theta)p}{1-\theta+\theta(1-p)}$$

- As $\theta \uparrow$, $V_\phi(\theta) \downarrow$: P responds more skeptically to $r = \phi$.
- *Ex ante expected value of V equals $p\theta(1) + (1 - p\theta)V_\phi(\theta) = p$, for all θ.*



Benchmark 2: P cannot observe what A learns but *can* observe (though not contract on) A's choice of θ

- In disclosure subgame, A discloses $x = 1$ and suppresses $x = 0$
- As in Benchmark 1, P's optimal response to $r = \phi$ is $V_\phi(\theta)$, which $\downarrow$ in θ.
- As in Benchmark 1, ex ante expected value of V is p, whatever θ A chooses, so marginal return to A of $\uparrow \theta$ is 0.
- Since $\uparrow \theta$ is costly for A, A's eqm choice of $\theta = 0$.



- cf. In Holmstrom's (1999) career-concerns model, if manager's effort is observed by firms, eqm effort will be 0.

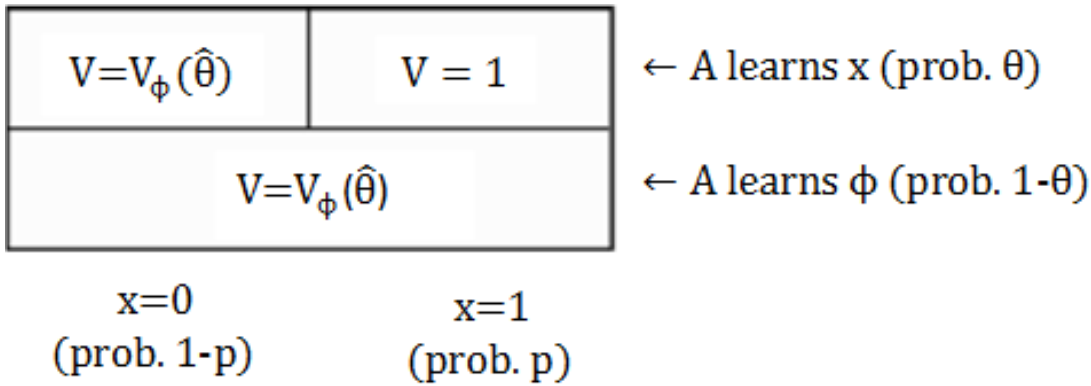
Benchmark 3: P cannot observe θ but *can* observe what A learns

This benchmark can represent regime of mandatory disclosure.

- Conditional on A learning x, P's expected decision $= p$.
- Conditional on A not learning x, P's expected decision $= p$.
- So marginal return to A of $\uparrow \theta$ is 0. Hence A's eqm choice of $\theta = 0$.

Benchmarks 2 and 3 imply that, for A to have strictly positive incentives to acquire information, it is necessary both that information acquisition effort be private and that strategic suppression of information be feasible.

Strategic disclosure preceded by strategic infor. acquisition by A:



- In disclosure subgame, A discloses $x = 1$ and suppresses $x = 0$
- Denote P's conjecture about θ by $\widehat{\theta}$, and denote P's optimal decision in response to $r = \phi$, for given $\widehat{\theta}$, by $V_\phi(\widehat{\theta})$
- Marginal benefit to A of $\uparrow \theta$, given P's conjecture $\widehat{\theta}$, is $p(1 - V_\phi(\widehat{\theta}))$
- Marginal cost to A of $\uparrow \theta$ is $C'(\theta)$
- Given $\widehat{\theta}$, in eqm. A's optimal choice of θ must equal $\widehat{\theta}$
- Hence eqm. value of $\widehat{\theta}$ must satisfy $p(1 - V_\phi(\widehat{\theta})) = C'(\widehat{\theta})$
- Since $p(1 - V_\phi(\widehat{\theta}))$ is $\uparrow$ in $\widehat{\theta}$, multiple equilibria are possible
- **But since $p(1 - V_\phi(\widehat{\theta})) > 0$ for all $\widehat{\theta} \in [0, 1]$ and $C'(0) = 0$, eqm. value(s) of $\widehat{\theta}$ must be strictly positive**

Implications of the model with information acquisition effort:

- A's incentives to acquire information are larger when disclosure is voluntary than when it is mandatory.
  - Consequently, in this specific model, P makes better decisions when disclosure is voluntary rather than mandatory.
- A's incentives to acquire information are larger when A's information acquisition effort is private than when it is public (but non-contractible).
  - Consequently, in this specific model, P makes better decisions when information acquisition effort is private rather than public.
- Both of the comparisons above are further illustrations that P's access to better info ex post can make him worse off ex ante.

General message: There are important interactions among

i) the environment for gathering and transmitting information (e.g. degree of transparency);

ii) incentives for gathering information; and

iii) incentives for transmitting information.